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ABSTRACT

Based on the assumption that educational technology transfers are vital to the continuing growth of all nations and that the issues connected with this activity are large and complex, this discussion addresses five major problems associated with international educational exchange: (1) inadequate understanding of the problem to be solved by technology, (2) conflicting theories which lead to conflicting employment of instructional methods, (3) misunderstandings about the science which underlies the technology, (4) vague definitions of technologies, and (5) unfortunate matches between problem and technology. After a review of the problems raised by each issue, suggestions for a solution or approaches which may lead to a solution are made. References are provided. (FM)

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ISSUES IN THE TRANSFER OF INSTRUCTIONAL TECHNOLOGY BETWEEN NATIONS

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ISSUES IN THE TRANSFER OF INSTRUCTIONAL TECHNOLOGY BETWEEN NATIONS

Technology results from the application of science and intuition to the search for solutions to problems. In its finished and successful forms, it is the most valued of commodities exchanged between nations. Without such exchanges going on constantly, each nation would need to rediscover solutions to all commonly experienced problems in education, energy production, transportation, agriculture and health care. And yet, there have been increasing doubts about the success rate of transfers of certain technologies between nations and cultures, notably those in education.

In the few instances where careful, long-term study of the effects of an educational technology transfer are carried out, important features of the transfer have been found to be apparently unsuccessful. Professor Thomas's description of the use of television in American Samoa (1980) and Scribner and Coles' (1978) study of nonformal literacy instruction among the Liberian and the Vai are important recent examples. In both cases an instructional technology was transferred to another nation in a large scale (and well publicized) effort to solve educational problems. In neither case was the transfer successful in the way it was originally planned and often the very visible problems it brought may have far outweighed some of the more invisible but suspected benefits. Of course, these two instances may be unique or unrepresentative. Since few long term studies are conducted, it is difficult to determine what the usual long term success rate has been for educational technology transfers. However, since we have some well documented instances of less than ideal successes, a closer examination of the processes and issues which surround this activity seem warranted.

One of the main reasons for the confused state of our present

knowledge is that our current definitions of instructional technology all include audio visual media. While television and other media are useful technologies for delivering instruction, there is solid evidence that they contribute nothing of value to learning and achievement, (Schramm, 1977). Media are more accurately conceived of as delivery technolgies. Instructional technology should be defined more broadly as programs, methods and techniques for training. This definition, employed in this presentation, rests on the assumption that, like other technologies, those designed for instruction derive from research on achievement and our prior experience with instructional solutions to learning problems. As such, the issues and problems associated with their use tend to be similar whether they are being employed within or between nations. There may, for example, be more differences in successful transfer methods between the east and west side populations of Los Angeles than between west side Los Angelenos and south side residents of Bogota. Despite this fact, there is a consistent reluctance for developing nations to accept instructional technologies produced in more developed nations. To the extent that this reluctance is based on the success rate of these transfers, this presentation is directed towards issues and problems which are thought to influence the success and failure of instructional programs.

Out of many possible issues which might have been selected, five major problems will be chosen for discussion: 1. Inadequate understanding of the problem to be solved by the technology; 2. Conflicting theories which lead to conflicting employment of instructional methods; 3. Misunderstandings about the science which underlies the technology; 4. Vague definitions of technologies; and 5. Unfortunate matches between problem and technology.

After a review of the problems raised by each issue, an attempt will be made to suggest a solution or an approach which may lead to a solution. The present discussion is based on the assumption that technology transfers are vital to the continuing growth of all nations and that the issues connected with this activity are large and complex. The ideas offered here are intended to contribute to the ongoing dialogue.

I. THE PROBLEM TO BE SOLVED BY TECHNOLOGY TRANSFER IS POORLY UNDERSTOOD BY THE TRANSFER SPECIALIST.

There are at least three types of misunderstanding: 1. The cultural or national bias of the developer or the adopter prevent shared understanding of a problem; 2. The attempt to solve one problem leads to other unanticipated problems; and 3. The problem which is addressed is not the problem which the adopter in fact thinks is being solved.

Cultural Bias

In the first instance, there are ample examples of disagreements between transfer teams and adopting nations over the problem to be addressed. The most dramatic recent examples concern the problem of world hunger. Technologies which are proposed to solve the problem range from high yield grain stock to population control devices. These two technologies reflect very different perspectives on the "problem." Less developed nations tend to see hunger as the root problem to be addressed by food supply technologies. More developed nations tend to view the problem as one of overpopulation and recommend birth control techniques.

In education this type of misunderstanding often occurs in the area of access to instruction. The fact that education is simply not available to a large percentage of the world's population is variously perceived: 1. as a problem in teacher training, and school construction; 2. as a local government attempt to control information and social reform; 3. as a problem with the delivery of instruction to rural people; 4. as an example of economic regression and 5. as a population control problem. The technologies available to address each of these views of the access to education differ greatly.

Unanticipated Problems

The second feature of this barrier is the often unrecognized interrelationships between problems. For example, an instructional technology which increases achievement and learning may, at the same time, reduce adopters participation in the instructional program. There is increasing evidence that some instructional techniques

which are the most effective in promoting achievement are also the most disliked by learners. Conversely, instructional methods which are liked may lead to minimal learning. Since continued willingness to participate in an instructional experience depends to some extent on the satisfaction experienced by students, it seems possible that we might solve a short term achievement problem at the long term jeopardy of the entire instructional program (cf. Clark, 1980). This problem interrelationship difficulty is also evident when a technology is resented by some sub group in the adopting setting. Teachers, for example, sometimes resent the use of televised instructional programs and occasionally work to dilute their effect. This may, in turn, reduce the morale of the teachers who end up working less effectively than they were before instructional television was introduced. (cf. Thomas, 1980). The end result may be a greater overall instructional problem than the one the technology was selected to address.

Transfer Goals

The third major difficulty here has been called the problem of the "referent generality" of outcomes, (Snow, 1977). Here the issue if the extent to which the problem which is addressed by the technology transfer actually represents the major long term difficulty which the adopter hopes to solve, that is, whether the solution (referent) to the problem addressed will generalize to the future goals of the educational program.

The goals of most educational improvement programs in third-world nations tend to be such things as improved quality of life for citizens, increased self esteem and ability to solve personal and family problems more effectively, and more knowledgeable participation in the political and cultural life of the nation. Since none of these problems can be addressed directly by reasonably manageable technologies, a decision always has to be made about which of the many short term problems which can be addressed will actually generalize to the solution of the larger and more long term goals for the educational system. The line of generalization from the solution of short term manageable problems to the addressing of larger and longer-term goals is not alwasy clear or very direct.

For example, Schribner & Cole (1978) studied the effects of literacy instruction on the Vai of Liberia and found that contrary to general expectations, teaching the Vai to read and write their language in a non-formal setting did not generalize to areas typically considered to be related to literacy, i.e. increases in verbal reasoning skills or the ability to deal with more abstract concepts. It led the researchers to claim that in this instance, the expectation that relatively short term instructional interventions would generalize to the solution of longer term goals was unwarranted. In many cases, cognitive skills are cultivated as a response to local cultural demands and needs and are not transferred to new skills or tasks unless the technology and local needs include provisions for the use of the skill in novel settings and problems.

Recommendation: The first two transfer barriers raised in this section, agreements over exactly what constitutes the problem being addressed and potentially antagonistic interrelationships between problems and solutions can be alleviated somewhat by careful prior agreements and planning. The decision about what constitutes the problem is clearly the domain of the adopter. It is equally clear that much of the controversy over technology transfers will continue to be due to the predisposition of more developed nations to negotiate over which problems experienced by lesser developed nations will be addressed before technologies will be provided. The second difficulty can be reduced somewhat by a combination of careful prior analysis of the potential each technological solution has to become an unanticipated solution and careful monitoring of the adoption process through formative evaluation and revision cycles (Forman, 1980).

The referent generality problem, while difficult, may be the easiest to solve given the present state of the art. There are many techniques available which will promote the generalization of skills acquired by learners through instructional technologies to wider varieties of problems. Essentially, this is a technology of the transfer of training within a nation and it involves presenting more complex opportunities to practice skills which are learned in increasingly greater varieties of situations. The many instructional techniques which define the technology include, the use of

identical elements, role playing, naturally occurring reinforcers, and simulations (these elements are discussed more completely in the next section).

II. EXISTING THEORIES OF TRANSFER APPEAR TO CONFLICT AND SUGGEST VERY DIFFERENT STRATEGIES FOR PROMOTING SUCCESSFUL INSTRUCTIONAL TECHNOLOGY TRANSFERS

This problem tends to be present in two areas: 1. All transfer specialists work with implicit or unconscious theories about the factors which enhance or inhibit technology adaptions; and 2. The two major formal and explicit theories of transfer which are based on existing research tend to conflict.

Unconscious Theories

Although many transfer specialists would reject the idea that they are constantly working with theories as they plan a transfer, in fact, all strategies which are used facilitate adaption of some instructional program spring from implicit theories about why one method or technique will work better than another. It is seemingly impossible to make decisions, personal or professional, without assumptions about the consequences of the decision. In this sense then, we all use theories. Assumptions, models, paradigms and rationales are all ways to describe our attempts to create a simplified picture of reality and use it to predict future events which would result from present activities. This natural inclination of both transfer and adoption planners is a difficulty only when we fail to make explicit the implicit theories which guide our decision. It often happens that there are very different assumptions about the factors which will make a technology succeed on the two ends of the exchange, which lead to conflicts and working at cross-purposes. Occasionally, for example, transfer teams will tend to assume that more participatory and self paced instructional methods will work best in the rural areas of developing nations. These types of methods are based on the theory that learners in this setting must be enticed to learn and will learn best at their own speed. Learners in a rural, poor adoption setting, on the other

hand, often expect more didactic methods to be employed and are usually highly motivated at the onset of instruction. On a more general level the difficulty is often one of different assumptions about what motivates the transfer process. Transfer specialists and managers often assume that adoption officials are motivated partially by personal gain. This tends to result in the use of more highly visible and expensive techniques being chosen for transfer. For their part, adoption officials sometimes assume that the transferring group is motivated by political gain and this tends to lead them to resist outside advice and influence over the adoption process and to be suspicious of highly visable and expensive techniques. The fact that these two conflicting sets of assumptions about motives are occasionally correct assessments of the situation at hand does not necessarily reduce the problem. Neither theory has much to do with the factors which promote the success of the transfer for the ultimate client...the learner. They are essentially theories about the threatening side effects of the transfer process not theories about what leads to the desired learning.

Conflicting Theories

The second major difficulty with the use of theory is that there are two existing psychological theories of transfer which suggest very different techniques for instruction, (Royer, 1979). On the one hand there is a considerable amount of research which has resulted from so-called "identical elements theory". This theory is based on the notion that the critical feature of all transfer situations is the entent to which the adoption situation is identical with the setting where the instruction was originally validated. This theory was originally designed to explain the transfer of learning for individuals and some stretch of the imagination (and the available data) is necessary to apply it to transfers of techniques between nations.

Identical Elements Techniques

Research on the identical elements theory has led to some very useful instructional techniques which can be built into instructional technologies such as:

-MODELING or simulating the behavior to be learned for the adoption group such that all crucial features of the behavior are depicted.

-ROLE PLAYING experiences are required during learning will allow the learners to simulate or role play the learning so they demonstrate it's use to themselves and others many times during the adoption process, and receive correcting feedback.

-INSURING IDENTICAL ELEMENTS in both the training and application situations. Here, the trainers work in the setting where the learning will be practiced or they attempt to simulate the crucial features of the application setting.

-OVERLEARNING the knowledge to be gained tends to insure that it will be practiced after the training is completed. This involves instructional programs that extend considerably beyond the point where they new behavior or knowledge has been minimally acquired.

-INCREASING VARIABILITY OF PRACTICE SETTING. After the knowledge is acquired and overlearned, its continued use is enhanced by incremental changes in the settings here it is practiced. This enhances the chances that skills will be used appropriately over a longer time and in a greater variety settings.

-LEARNING MAINTENANCE TECHNIQUES such as: 1. the substitution of naturally occurring rewards for practicing the new knowledge (e.g. substituting kind words from family and peers for trainer reinforcement); 2. change trainers by substituting peer trainers, and 3. provide for the gradual reduction of naturally occurring reinforcement from peers so that it is intermittant and not constant. This serves to gradually inc.ease learner control over the practice of what is learned by teaching learners to notice and control their practice.

-INNOCULATION AFTER DELAY. Build into the technology transfer the opportunity/requirement to follow up the results of the training after a reasonable period of time to reinstate and redirect the practice of the learned behavior (i.e. to innoculate against the disintegration).

The second theory of transfer deals less with instructional techniques than with a description of the internal, mental or cognitive events which take place when learning is transferred from the place where it is learned to the place where it will be practiced. Here again some imagination and speculation is necessary to apply this cognitive theory to exchanges between nations. Cognitive theory is in a more formative stage than the identical elements theory and there is relatively less research evidence for its success. It is based loosely on information processing theory and it assumes that identical transfer theory tends to promote learning without understanding or comprehension (by rote learning and practice for example). It presumes that the more understood a concept is the more able a learner will be to use it in a variety of self-determined situations. All of the techniques for instruction which flow from cognitive theory have one crucial element: it is necessary for the instructional designer to determine which of the many existing skills and understandings that have been acquired by the learner are applicable to the "to be acquired" knowledge. The presumption is that learning and eventual comprehension of new knowledge will be enhanced if previously learned information is seen as analogous to the new technology. Most of the instructional techniques which will be developed in the future in the cognitive approach will be attempts to increase the "richness" of the connections between previous experience and new information to be learned.

One of the more obvious implications of cognitive theory is that the transfer specialist must have as complete a picture as possible of the existing skills and knowledge of the learner population. Rather than being concerned with the source of rewards or simulation techniques which concern the identical elements theorist, cognitivists would attempt to use familiar experiences as analogies which would activate previously learned information and related it to new information. For example, if the adopting group were agriculturally oriented, the cognitivist might assume that analogies which draw upon knowledge of complex systems of planting, harvesting, weather, irrigation, cultivation and the

actions of insects on plants. Health care instruction might be related to procedures for protection against the actions of destructive insects on crops. These analogies tend to be of two types: 1. What is involved analogies and 2. How to accomplish analogies. What is involved analogies relate the elements of a familiar event to those which are to be learned. We might for example, make an analogy between the crucial reasons for digging a well (to be learned) and the decisions which surround the building of a safe dwelling (already learned). How to accomplish analogies are attempts to relate new procedures to those already learned. For example, the steps in digging a safe well might be associated with the steps necessary to plant a new crop.

I should be obvious from the above description that in cognitive theory, the critical aspect of transfer does not revolve around identical elements in the learning environment. It is instead an attempt to promote the retrieval of previously learned skills and knowledge and encourage their application to new information. In this sense therefore, there is a real difference between the basic assumptions of the two theories and the exact instructional remedies they suggest. It is one of the basic rules of science that two theories about the same phenomenon cannot both be correct. An attempt to use either theory then is colored with a good measure of uncertainty and the chance that the technology transfer will be less than successful.

Recommendation: In all transfer situations there should be a systematic attempt by both transfer specialists and adopters to make the implicit theories contained in the technology and the transfer plan more explicit. This kind of examination can only strengthen both the technology and the transfer. When they are made explicit, our unexamined assumptions can be checked for soundness. If we suspect that some aspect of our implicit theories are faulty, then we must reexamine that part of the instructional technology which resulted from the flawed assumption. If we reconfirm our trust in the validity of a particular assumption we have still contributed to the success of the transfer. The assumptions underlying our instructional techniques are essentially

reasons why they should work in a certain way. If they are found not to work, we have the advantage of questioning our assumption and revising it rather than repeating the same error again.

In the case of the two conflicting formal theories, it is possible that the conflict might be solved by using each of the theories at different stages in the transfer process. The transfer techniques suggested by cognitive theory are probably more useful in the initial stages of transfer planning and identical elements techniques should be used in later stages. This resolution of the problem more accurately reflects the research available to buttress the theories and makes it unnecessary to either choose between two apparently conflicting approaches or to combine them in some way.

In the initial stages of a transfer it would be most beneficial if the transfer specialist makes a systematic accounting of the existing skills and knowledge of the adoption group which are relevant to the acquisition of the to-be-transferred technology. Initial instructional plans then will be able to draw upon readily available experience in the adopting group which will promote the understanding and comprehension of the "new" technology. Most often this will involve the use of familiar and analogous examples from the everyday experience of the adopting group which relate to the crucial features of the technology. Wittrock (1979) and Royer (1979) have given examples of other possible uses of the cognitive approach in, for example, the design of technologies, and the evaluation of their success.

Once a rationale and familiar experience for the technology to be adopted have been firmly established, the identical elements techniques can be employed to insure that the important features of the technology are practiced, reinforced and extended to the everyday behavior of the adopters. Here the emphasis is less on the understanding of the technology in familiar terms than it is on the establishing of habits for using the technology in daily life over extended periods of time. Where the cognitive theory based techniques attempt to insure that the adopters <u>understand</u> why the technology is important, what elements are <u>crucial</u> and how it should be <u>practiced</u>; the identical elements techniques

attempt to insure that the technology is practiced appropriately, successfully and consistently over time. The identical elements techniques also attempt to insure that the practice of the technology is firmly in the control of the adopting group which reduces the demand for continued outside support.

III. WHEN THE SCIENCE UNDERLYING THE TECHNOLOGY IS INADEQUATELY DEVELOPED OR POORLY UNDERSTOOD BY THE TECHNOLOGIST

What was the obvious strength of the technology developed for the exploration of space, a strong and well developed underlying science, is potentially the most important weakness for the successful transfer of instructional technology. Most of the instructional methods we have available are based on behavioral science models which are in their infancy and therefore vulnerable to misapplication and misunderstanding.

The External Validity of Technologies

The specific problem one finds here is the misapplication of instructional models and theories beyond a resonable range of generalizability. This is what the research design specialist calls a problem in the external validity of findings from educational research. Those factors which usually limit the findings of existing research are their extension to different people, settings, and times...nearly all of which are present in any transfer of technology situation.

For example, most instructional theories and techniques are validated in controlled studies which utilize very specific and narrowly chosen populations; what might be called YAVIS individuals... Young, Affluent, Verbal, Independent and Schooled. Since technologies tend to flow from more developed to less developed nations, populations in recipient nations tend to be RUPAS peoples...Rural, Unschooled, Poor, Agricultural and Social or family oriented.

Another problem is the atte pt by technologists to generalize from research studies which have tested the effects of instructional techniques with subject populations for the standard thirty minutes of experimental time. One might reasonably question the extent to

which an instructional method which was tested with YAVIS students for a brief time would generalize to a group of RUPAS people who are using the method over periods of months or years. There is ample evidence from recent research that people react very differently to instructional methods over time. Those methods which are successful at the onset of instruction very often loose their potency later on and conversely those which are unsuccessful at first often prove to be useful in later stages of instruction.

Recommendation: Any attempt to solve these problems must involve both our existing science and the development and transfer of technology process.

Aptitude-Treatment Interaction

Researchers need to be encouraged to utilize theories which take relevant learner differences into account as main factors in the development of theories of instruction. The current model which holds the most promise for eventually increasing the transferability or external validity of instructional methods is called the "aptitude-treatment interaction" (ATI) approach to instructional research (cf. Cronbach & Snow, 1977). This approach, which promises to bring more coherance generally to educational research, makes it possible to generate models of instruction based on their appropriateness for different people. It is based on the presumption that different people learn differently and that the task of both the researcher and the developer is to find the most ideal match between different instructional methods and recipient groups or individuals. An attempt is made to use more or less universal characteristics of people such as fluid or crystallized ability, spatial skills, locus of control, sociability, conformity, independence, anxiety, need for affiliation plus aptitudes which are much more specific and relate to the prior knowledge of crucial elements of tasks which must be learned. The ATI approach, if properly applied in research, will also increase the chances that we will know why something is expected to work in a specific setting with a specific group of learners.

Formative Evaluation

Even if the ATI approach is applied universally in the science which underlies most technology, it will still be necessary for the transfer technologist to accomodate unanticipated features of a transfer situation. There will always be unique factors which effect the success of our attempts to adapt instructional technologies. The most valuable "adjustment" technique for all instances is formative development and evaluation. In this approach, various methods are available for small but important field tests and revisions of key concepts in the instructional program with local groups. The results of such formative tests is information about their local success, and the discovery of factors which are unique to the transfer situation which influence the success of the technology. Technologists can then use this information to make field revisions of techniques. Formative evaluation and revision, when properly applied, reduces the need for developing nations to spend disproportionate amounts of development budgets in building a local educational science. If properly conducted, formative development and evaluation may, lead to clearer understandings about the unique factors which enhance and inhibit educational programs (cf. Cooley & Lohnes, 1977). Of course formative activities are costly in time and effort. However, they must be considered in the planning of transfers. Current evidence suggests that the alternative is visable failures and invisable successes.

The Training of Transfer Specialists

Finally, it is necessary for transfer technologists to receive much more adequate training in the science which underlies instructional methods and techniques. Clark (1978), in a survey of doctoral programs which train instructional technologists found evidence for inadequate training in those skills which would insure the most accurate use of research based knowledge in the development and transfer process. Most alarmingly however, was the report by those who manage major U.S. doctoral programs that future plans call for an even further move away from research elements in instructional technology graduate curriculums. While the need for instructional technologists to understand the art of development is increasingly recognized and valued, the experience of more

established technology based professions such as engineering and medicine suggest that a strong background in the methods and results of research are a necessary condition for the successful development and transfer of valuable educational innovations.

IV. INSTRUCTIONAL TECHNIQUES AND METHODS WHICH FORM THE BASIS OF PROGRAMS WHICH ARE TRANSFERRED ARE NOT CLEARLY CONCEPTUALIZED OR DESCRIBED BY DEVELOPERS.

One of the most dramatic examples of this difficulty in instructional technology is the undue emphasis which we place on the role of communication media in education.

Technology as Media

In fact, there is clear evidence that such media do not and should not be expected to enhance educational achievement. They are simply delivery devices which transmit instructional programs. Since they are based on a well developed technology however, their use has somehow been confused with the much more important issue of which many instructional programs and methods are most useful in promoting learning. This misunderstanding has resulted in the development of many so-called "media selection schemes" which presumably match learning needs with the media which will most adequately instruct. If the problem to be addressed is one of transmitting instruction to remote groups or very large populations when the number of teachers or geographical barriers prevent delivery then the newer communication media are worthy of consideration. Wilbur Schramm (1979) has recently noted however, that learning and achievement are more effected by the techniques we employ in the instructional act than by the medium which we choose to deliver instruction. He argues persuasively that if achievement differs as a result of students exposure to two different media (for example, televised instruction versus teacher presented instruction), one would have to conclude that the difference was due to factors other than the television or the teacher. In order to establish the

superior capability of one medium over another it would be necessary to control al. factors which might contribute to learning other than the medium. In other words, the teacher would have to teach on the television and simultaneously in a non-TV situation. In such a test, one would not expect differences in achievement between TV and non TV groups which would be due to the medium. Therefore, the most important issue, seldom addressed by instructional technologists, is which of the many instructional methods which are available should be transmitted by an instructional medium. This decision rests less on the medium of instruction than on our current knowledge of instructional research and development.

One additional factor is important. Since transfers tend to occur from more wealthy and developed to less wealthy and developed nations, the cost of the instructional delivery device is often paramount. Developing nations often articulate a need for the cheapest and most effective instructional technology for accomplishing their educational goals. When relatively expensive communication media are offered as technologies which will enhance achievement (even by implication), the technologists have misrepresented their capabilities and paved the way for a potentially expensive transfer failure. The time and expense invested in installing sophisticated communication media is not matched by effort invested in the more important and demanding but less visable instructional method selection and development.

The Specification of Technologies

Admittedly, the precision with which instructional techniques and methods are described is inadequate at best. The most popular current methods such as individualized instruction, learner controlled methods, mastery learning approaches, Keller plan, open classroom methods, audio-tutorial laboratory, multi-image instruction, computer assisted instruction and so on are so carelessly and generally described for those who wish to employ them that many are no more than slogans. The difficulty with this state of affairs is that when these approaches are transferred between nations, the specific instructional acts they designate are interpreted very differently by different adopters. The end result does not reflect the actual set of operations for which we have research evi-

dence of success or developmental experience. The typical failure which results is often therefore interpreted as a deficiency in the original concept rather than a simple lack of adequate specification of the crucial elements of the technique.

There are of course many instructional techniques which have been specified with some precision. Among them are reinforcement and token instructional systems, programmed instruction, and a number of instructional support techniques such as cueing, underlining, advance organizers, note taking, modeling, role playing, inserted questions, and the use of imagery. Even here however the developer has a difficulty. It appears from recent research that nearly all of these better specified methods of enhancing achievement work with some learners and not with others. (Snow, 1979) The current direction is to demand that instructional techniques not only be clearly specified by their crucial features but by a clear description of the function they serve in learning for different types of students.

Recommendation: There have been a number of recent suggestions for overcoming this problem, the most promising may be those described by Rhetts (1974 and Salomon 1979).

Instructional Development

Rhetts suggests a problem solving strategy which is similar to many of the current development strategies but which places much more emphasis on the specification and study of the instructional methods employed in an educational program. His proceedure is detailed and is worth studying.

Functional Analysis

Salomon (1979 provides what he calls a functional approach to the conceptualizing of instructional methods. He describes three models for thinking about the function of all methods and gives a number of examples of each. His first model, remedial functions, is based on the large body of research and practice best represented in the work of Gagne, Merrill, Ausubel and to some extent, Skinner. His compensatory model is based in the current work being conducted by cognitive psychologists and developmental psycholinguists and his preferential model, the most speculative is loosly based on the current work on human abilities and the field of special education.

V. THERE IS AN INADEQUATE MATCH BETWEEN THE PROBLEM AND THE TECHNOLOGY.

There are two major types of barriers that are related to this problem: 1. The predisposition which most technology transfer specialists have to choose a specific technology and search for a problem which it will fit; and 2. the tendency we have to apply technologies inappropriately to features of problems which they were not designed to address.

Technology Advocacy

Whenever we become advocates for a particular technology the temptation is great to apply it inappropriately to a problem. This situation leads to unsuccessful transfer for obvious reasons. The most common example of this difficulty is the attempt to "sell" the use of electronic media to increase learning or to advocate an instructional technique such as programmed instruction regardless of the problem which needs attention. Although highly visable, electronic media by themselves do not address learning difficulties. Programmed instruction and other instructional methods have been found to be more appropriate for some learners and learning content than for others (recent research seems to indicate that programmed instruction works better with lower ability students and/or when highly novel content is being taught). Since nearly all technologies are limited in their scope--in the problems which they can help to alleviate--limitations on their use is a potential problem in all transfer situations.

Process Analysis

The inappropriate matching of problems and solutions also extends to misunderstandings about the specific point in the learning process to which an instructional technique is directed and most effective. Relatively complex learning contains many different stages and process for each individual learner. Instructional strategies which characterize a given technology tend to be effective in promoting one or two stages in cognitive processing during learning but not at others. Although educational psychologists differ in the number and characterization of learning stages, most would agree that all learners must be engaged by the task (i.e. motivated,

attending), that they must be able to decode the instructional materials and understand what is expected of them (the so-called "demand characteristics" of the instruction); that they must be able to call forth experience and remembered skills which are required to manipulate or solve the task appropriately; and that the way they solved the task must be stored in such a way that it can be retrieved from memory and applied (generalized) to a simila task at a different time and place (retrieval and transfer of learning). Instructional technologies which would assist in the earlier stages of learning, say programmed instruction, would not necessarily be helpful in storage, retrieval or transfer. Similarily, the use of memory devices such as visual imagery which aid storage and retrieval would probably not enhance the solution stage. Transfer techniques such as identical elements and role playing may aid engagement and understanding the task as well as transferring what is learned to new situations but not assist in storage or manipulation of the task problem. The key point here is that any one of these technologies can be inappropriately applied--at the wrong stage in the learning process. They can also be appropriately applied and learning or transfer can fail to occur because they were directed towards only one or two stages and not assisted through the entire range of the learning process stages.

Recommendation: In order to prevent the misapplication of technologies to inappropriate problems it would be useful to encourage technology transfer specialists to think of their professional roles as brokers of technology rather then as advocates for specific technologies.

Technology Brokering

The client for technology should look for a transfer specilist who is expert in a variety of techniques and who has experience in matching problems with appropriate solutions. In addition it would be useful for the developers of instructional technologies to describe them in such a way that the problems which they were designed and those for which they are contrindicated to solve are clearly described along with their other more obvious features.

Analysis Tasks

Applying technologies to the full range of stages in the acquisition and transfer of knowledge can be enhanced with careful analysis of the instructional task during the technology selection and adoption process. Various task analysis schemes have been proposed by Rhetts (1974). Most instructional technology development models contain a procedure which enhances the chance that instruction will nurture all aspects of the learning process. It only remains for the available models to be used in development and adoption.

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